Software-Defined Networking
- The New Norm for Networks
Shri V.Balasubramanyam, Instructor Telecom/IRISET

1. Introduction

Conventional network architectures are poorly-suited to meet the requirements of today’s enterprises, service provider and end users. Software Defined Networking (SDN) is transforming networking architecture in which the control and data planes are decoupled, network intelligence and state are logically centralized, and the underlying network infrastructure is abstracted from the applications. As a result, enterprises and service provider gain unprecedented programmability, automation, and network control, enabling them to build highly scalable, flexible networks that readily adapt to changing business needs.

OpenFlow is the first standard interface designed specifically for SDN, providing high-performance, granular traffic control across multiple vendors’ network devices. OpenFlow-based SDN is currently being rolled out in a variety of networking devices and software, delivering substantial benefits to both enterprises and service provider, including:

- Centralized management and control of networking devices from multiple vendors;
- Improved automation and management by using common APIs to abstract the underlying networking details.
- Rapid innovation through the ability to deliver new network capabilities and services without the need to configure individual devices or wait for vendor releases;
- Programmability by operators, enterprises, independent software vendors, and users (not just equipment manufacturers) using common programming environments, which gives all parties new opportunities to drive revenue and differentiation;
- Increased network reliability and security as a result of centralized and automated management of network devices, uniform policy enforcement, and fewer configuration errors;
- More granular network control with the ability to apply comprehensive and wide-ranging policies at the session, user, device, and application levels; and
- Better end-user experience as applications exploit centralized network state information to seamlessly adapt network behavior to user needs.

SDN is a dynamic and flexible network architecture that protects existing investments while future-proofing the network. With SDN, today’s static network can evolve into an extensible service delivery platform capable of responding rapidly to changing business, end-user, and market needs.

2. The Need for a New Network Architecture

The explosion of mobile devices and content, server virtualization, and advent of cloud services are among the trends driving the networking industry to reexamine traditional network architectures. Many conventional networks are hierarchical, built with tiers of Ethernet switches arranged in a tree structure. This design made sense when client-server computing was dominant, but such a static architecture is ill-suited to the dynamic computing and storage needs of today’s enterprise data centers, campuses, and carrier environments.

Some of the key computing trends driving the need for a new network paradigm include:

- **Changing traffic patterns**: Within the enterprise data center, traffic patterns have changed significantly. In contrast to client-server applications where the bulk of the communication occurs between one client and one server, today’s applications access different databases and servers.
- **The “Consumerization of IT”**: Users are increasingly employing mobile personal devices such as
smartphones, tablets, and notebooks to access the corporate network. IT is under pressure to accommodate these personal devices in a fine-grained manner while protecting corporate data and intellectual property and meeting compliance mandates.

♦ **The rise of cloud services**: Enterprises have enthusiastically embraced both public and private cloud services, resulting in unprecedented growth of these services. Enterprise business units now want the agility to access applications, infrastructure, and other IT resources on demand.

♦ **“Big data” means more bandwidth**: Handling today’s “big data” or mega datasets requires massive parallel processing on thousands of servers, all of which need direct connections to each other. The rise of mega datasets is fueling a constant demand for additional network capacity in the data center.

3. **Limitations of Current Networking Technologies**

Meeting current market requirements is virtually impossible with traditional network architectures. Faced with flat or reduced budgets, enterprise IT departments are trying to squeeze the most from their networks using device-level management tools and manual processes. Service providers face similar challenges as demand for mobility and bandwidth explodes. Network designers are constrained by the limitations of current networks, which include:

♦ Complexity that leads to stasis (state of inactivity)
♦ Inconsistent policies
♦ Inability to scale
♦ Vendor dependence

4. **Software-Defined Networking Architecture**

Software Defined Networking (SDN) is an emerging network architecture where network control is decoupled from forwarding and is directly programmable. This migration of control, formerly tightly bound in individual network devices, into accessible computing devices enables the underlying infrastructure to be abstracted for applications and network services, which can treat the network as a logical or virtual entity.

The SDN architecture is:

**Directly programmable**: Network control is directly programmable because it is decoupled from forwarding functions.

**Agile**: Abstracting control from forwarding lets administrators dynamically adjust network-wide traffic flow to meet changing needs.

**Centrally managed**: Network intelligence is (logically) centralized in software-based SDN controllers that maintain a global view of the network, which appears to applications and policy engines as a single, logical switch.

**Programmatically configured**: SDN lets network managers configure, manage, secure, and optimize network resources very quickly via dynamic, automated SDN programs, which they can write themselves as the programs do not depend on proprietary software.

**Open standards-based and vendor-neutral**: When implemented through open standards, SDN simplifies network design and operation because instructions are provided by SDN controllers instead of multiple, vendor-specific devices and protocols.

![Figure: The SDN System Architecture](image-url)
Figure depicts a logical view of the SDN architecture. Network intelligence is (logically) centralized in software-based SDN controllers, which maintain a global view of the network.

As a result, the network appears to the applications and policy engines as a single, logical switch. With SDN, enterprises and service providers gain vendor-independent control over the entire network from a single logical point, which greatly simplifies the network design and operation. SDN also greatly simplifies the network devices themselves, since they no longer need to understand and process thousands of protocol standards but merely accept instructions from the SDN controllers.

Perhaps most importantly, network operators and administrators can programatically configure this simplified network abstraction rather than having to hand-code tens of thousands of lines of configuration scattered among thousands of devices. In addition, leveraging the SDN controller’s centralized intelligence, IT can alter network behavior in real-time and deploy new applications and network services in a matter of hours or days, rather than the weeks or months needed today.

By centralizing network state in the control layer, SDN gives network managers the flexibility to configure, manage, secure, and optimize network resources via dynamic, automated SDN programs. Moreover, they can write these programs themselves and not wait for features to be embedded in vendors’ proprietary and closed software environments in the middle of the network.

In addition to abstracting the network, SDN architectures support a set of APIs that make it possible to implement common network services, including routing, multicast, security, access control, bandwidth management, traffic engineering, quality of service, processor and storage optimization, energy usage, and all forms of policy management, custom tailored to meet business objectives. For example, an SDN architecture makes it easy to define and enforce consistent policies across both wired and wireless connections on a campus.

Likewise, SDN makes it possible to manage the entire network through intelligent orchestration and provisioning systems. Thus, with open APIs between the SDN control and applications layers, business applications can operate on an abstraction of the network, leveraging network services and capabilities without being tied to the details of their implementation. SDN makes the network not so much “application-aware” as “application-customized” and applications not so much “network-aware” as “network-capability-aware”. As a result, computing, storage, and network resources can be optimized.

5. CONCLUSION

Trends such as user mobility, server virtualization, IT-as-a-Service, and the need rapidly to respond to changing business conditions place significant demands on the network—demands that today’s conventional network architectures can’t handle.

Software-Defined Networking provides a new, dynamic network architecture that transforms traditional network backbones into rich service-delivery platforms. By decoupling the network control and data planes, OpenFlow-based SDN architecture abstracts the underlying infrastructure from the applications that use it, allowing the network to become as programmable and manageable at scale as the computer infrastructure that it increasingly resembles.

An SDN approach promotes network virtualization, enabling IT staff to manage their servers, applications, storage, and networks with a common approach and tool set. Whether in a service provider environment or enterprise data center and campus, SDN adoption can improve network manageability, scalability, and agility.

OpenFlow switching is already being incorporated into a number of infrastructure designs, both physical and virtual, as well as SDN controller software. The future of networking will rely more and more on software, which will accelerate the pace of innovation for networks as it has in the computing and storage domains.

SDN promises to transform today’s static networks into flexible, programmable platforms with the intelligence to allocate resources dynamically, the scale to support enormous data centers and the virtualization needed to support dynamic, highly automated, and secure cloud environments.

With its many advantages and astonishing industry momentum, SDN is on the way to becoming the new norm for networks.